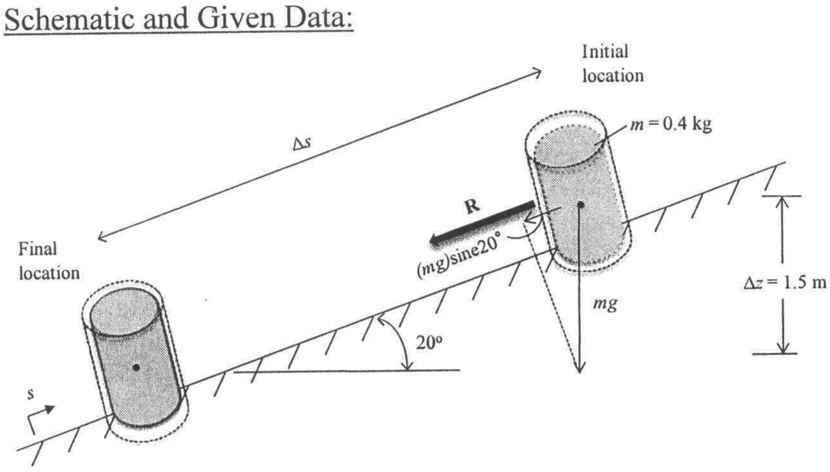
PROBLEM 2.15

Known: Can moves down a surface that is inclined relative to the horizontal. The can is acted upon by a constant force parallel to the incline and by the force of gravity.

Find: Can's change in kinetic energy, in J, and whether it is *increasing* or *decreasing*. If friction between the can and the inclined surface were significant, what effect would that have on the value of the change in kinetic energy?

Schematic and Given Data:



Engineering Model:
(1) The can is a closed system.
(2) The acceleration of gravity is constant.
(3) The applied force **R** is constant.
(4) Ignore friction between the can and inclined surface.

Analysis:

Begin with Eq. 2.6

$$\int_{s_1}^{s_2} \underline{F} \cdot d\underline{s} = \frac{1}{2} m\left(V_2^2 - V_1^2\right) = \Delta KE \qquad (1)$$

From the free body diagram in the schematic, the dot product can be expressed as

$$\underline{F} \cdot d\underline{s} = \left(\mathbf{R} + (mg)\text{sine}20^\circ\right)ds$$

Substituting into Eq. (1)

$$\int_{s_1}^{s_2} \underline{F} \cdot d\underline{s} = \int_{s_1}^{s_2} \left(\mathbf{R} + (mg)\text{sine}20^\circ\right)ds = \Delta KE \qquad (2)$$

Since Δz = Δs sine 20°, Eq. (2) becomes

$$\int_{s_1}^{s_2} (\mathbf{R})ds + (mg)\Delta z = (\mathbf{R})\Delta s + (mg)\Delta z = \Delta KE \qquad (3)$$

Evaluate Δs

$$\Delta s = \frac{\Delta z}{\text{sine}\,20^\circ} = \frac{1.5\text{ m}}{0.342} = 4.39\text{ m}$$

Subsituting all known and calculated data into Eq. (3)

$$\Delta KE = (0.05N)(4.39m)\left|\frac{1J}{1N \cdot m}\right| + (0.4kg)\left(9.8\frac{m}{s^2}\right)(1.5m)\left|\frac{1N}{1\frac{kg \cdot m}{s^2}}\right|\left|\frac{1J}{1N \cdot m}\right| =$$

(#1) $\Delta KE = 0.22\text{ J} + 5.88\text{ J} = 6.1\text{ J}$ ←

Which corresponds to an *increase* in kinetic energy. ←

If friction were significant, the magnitude of the net force acting in the direction of motion would be less, and thus the kinetic energy change would be less than calculated. ←

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1. Observe that in the absence of the force **R** the can is acted on only by gravity, and the can's change in kinetic energy is 5.88 J.